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Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

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JUN 2 2006
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In the Matter of)

Review of the Emergency Alert System)

EB Docket No. 04-296

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To: The Commission

While I have filed a reply comment to the EB Docket 04-296 FNPRM regarding EAS at the end of December last year, and late filings since (2006-02-14 and another regarding "A Coding Method for Language Selection", I wish to submit another late filing. This concerns "Latitude and Longitude Formats and Forward Error Correction (FEC) Algorithm.". It is Appendix B of a book I am writing about the Emergency Alert System, which is currently over 120 pages (A size). The last approximately eight pages of the FEC algorithm are only correct in outline, and shall be corrected as time permits. A trial encoding has been done, but a trial decoding and FEC has to be done after the algorithm is fully written. This material, including the book draft, has not been distributed to anyone other than this submission which follows.

The algorithm includes measures to detect and correct errors, and also to provide a degree of security for the EAS message. This can be extended to provide security for the complete message without breaking the EAS protocol, and keeping it readable in the clear. The National Weather Radio system has another format for Latitude and Longitude, which is provided for in the algorithm, however the recommended format provides for;

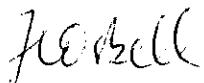
- 1) The ability to selectively or completely use latitude and longitude, as noted previously.
- 2) The ability to have variable resolution down to very small polygons. Latitude and longitude are more suitable for weather alerts and mobile public. Small areas are suitable for gas main breaks and such local problems where time is of the essence and the first responders could benefit from assistance from this alerting technology.
- 3) Forward Error Correction will improve transmission when noise or other errors degrade the signal. The NWR format does not provide for that.
- 4) All quadrants of the globe are provided for. NWR only provides for North and West, so it is not applicable to the end of the Aleutians without exceeding 180° which is an inconsistent value.
- 5) Security codes can be transmitted that can have FEC applied to them, by using values over 180° longitude (up to 199.99999) or 90° latitude (up to 99.99999).
- 6) The algorithm following is not intended to be made public. The deliberately contorted nature if it is to considerably raise the difficulty for anyone attempting to crack it.

Another appendix on "The Economics of Disaster Mitigation" follows for your information.

This proposed EAS modification would need consideration by EAS manufacturers and testing to see if unexpected behaviors occurred with currently used software versions in all current encoders/decoders. Accordingly please find attached;

- a) Latitude and Longitude Formats and Forward Error Correction (FEC) Algorithm, and
- b) The Economics of Disaster Mitigation.

Sincerely,



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Appendix A; Latitude and Longitude formats and Forward Error Correction (FEC) Algorithm.

The U.S. NWS latitude and longitude format is illustrated by;

```
LAT...LON 3165 8940 3179 8939 3180 8904  
3176 8904 3175 8902 3173 8904 3173  
8907 3170 8912 3163 8938
```

\$\$

The numbers are two decimal places of degrees at the end with the degrees before them. This example has no hundreds of degrees. Minutes are not used, as the example has more than 59. They are in pairs, with the latitude preceding the longitude. This example is a 9 point polygon. It is always North latitude and West longitude. Latitude precedes longitude because in navigation, latitude was a known factor before the longitude was. The blank line before the \$\$ is optional. The tab on the second and third lines is optional. The \$\$ denotes the end of the message and the latitude and longitude is always the last item.

The proposed EAS format is illustrated by;

```
LAT.LON N52. (AB) E172.2 (ABC) N52.0 (ABC) W177.45 (ABCD) N51.02536  
(ABCDEF) W177.451 (ABCD) N50.0096 (ABCDE) E172.176 (ABCD)
```

\$\$

The decimal points can be followed up to 5 places resolution. The N, W, E, or S will be in the first character position because they are equivalent to a sign in arithmetic. They are in pairs, but the order within the pair should not be of concern to any software developed. Rather, all the pairs should have the same order for human convenience. The following blank line is [CR][LF] and is not necessary if \$\$ is there. For processing efficiency, the LAT.LON string should be the first thing in the body after the header so the microprocessor can be processing that while receiving the rest of the message. Then determination as to whether the receiver is in the area specified can proceed. The (AB...) sections are the forward error detection and correction characters used as part of the algorithm described elsewhere. The example crosses 180 degrees. This algorithm is rather contorted. That is deliberate so as to greatly increase the difficulty of reverse-engineering it. So this algorithm also aids the security by making it difficult to generate unauthorized messages. End of line is [CR][LF].

The algorithm is not made public, but would be on the next pages if included. The brackets and their contents must not be displayed to the public. As this algorithm needs to be executed in devices like car radios, it cannot be too complex, also there is no possibility of the algorithm being upgraded as it has to be in firmware. The polygons are defined as enclosing areas for alert messages. There are no interior polygons included unless the shape is like a "C". Rumb lines are the connections between the vertices, these are simpler for small microprocessors to process. The north and south poles can be included if a polygon surround them, the polygon can only be in one hemisphere if that is so for simpler software. So the security is provided by inaccessibility from the public, which is one level. System security needs provision by other means, some of which are outlined elsewhere. Currently some exercising of the algorithm needs to be done to debug it but that should be completed soon. It provides for near or crossing of the equator or the 0° or 180° longitudes. If the bit error(s) in a character cannot be determined and corrected, but are too numerous, the character shall be followed by a "?". Then the polygon drawing algorithm can construct the largest polygon with the value that is unknown, this errs on the side of safety. Also the display of the ? alerts the public to a signal quality issue.

Also it provides for a secure mode which is accessed by using position N99. E199. To set and S99. W199. to clear this mode. In this mode, positions which can be from 90. to 99.99999 latitude and 180. to 199.99999 longitude can be used for county and sector positions and the FEC security mechanism will still work. However such positions shall not be displayed to the public, and the value of the sector shall be 0 to 9 only. This is an unusual FEC method in that it is human-readable. This is to be compatible with existing EAS equipment and for viewing by operators. It is advantageous that the security switches are passed through forward error correction. However they should be repeated also for reliability. This FEC algorithm is good against random noise, however it can be susceptible to burst noise. For improved reliability, the LAT.LON string can be repeated on a new line and the characters followed by a ? can be replaced with acceptable data from the second copy. If there are discrepancies between accepted characters, the output of them shall be followed by a ?, but that should be infrequent.

The NMEA-0183 format may be used for data from a GPS or other navigation device. Its' format is illustrated by:

\$\$GP,GGA, hhmmss.sss, ddmm.mmmm, N, dddmm.mmmm, E, F, SU, HD.P, AL.T, M, G, M, D
GPSA, DGPS, CHK[CR]LF]

Where GP means that a GPS is the talker identifier. GGA means that it is a global positioning system fix data sentence.

hhmmss.ss is the fix time (UTC).

ddd or dd are the degrees. mm.mmmm are the minutes

N may be S, E may be W,

F is position fix (0 = Invalid, 1 = Valid SPS, 2 = Valid DGPS, 3 = Valid PPS)

SU Satellites Used (2 digits, presently 12 max.)

HD.P Horizontal Dilution of Position (same units as altitude)

AL.T Altitude (based on WGS-84 ellipsoid)

M meters, units of HD.P and AL.T

G Geoid separation

M meters, units of geoid separation

DGPSA Age of DGPS data in seconds

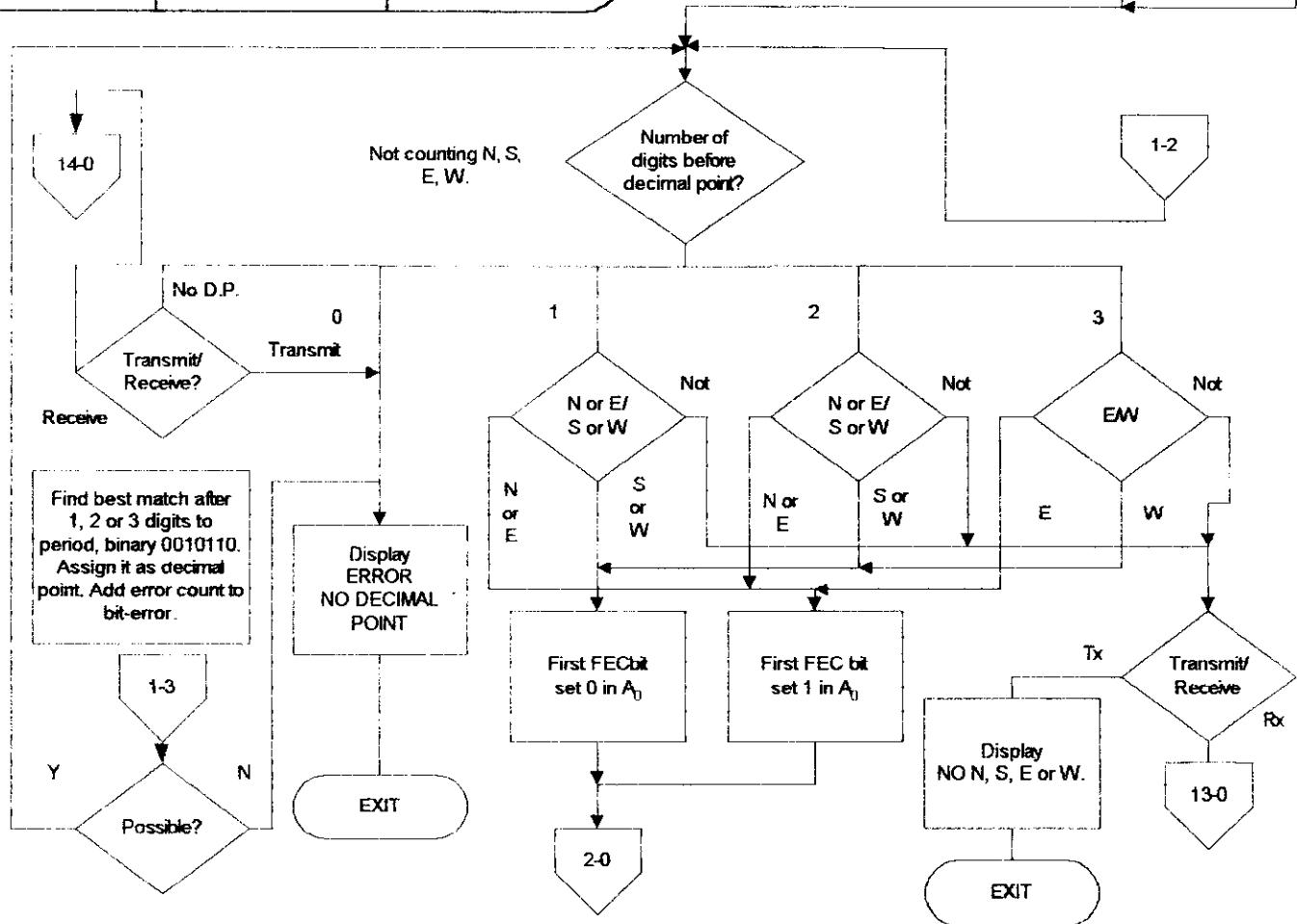
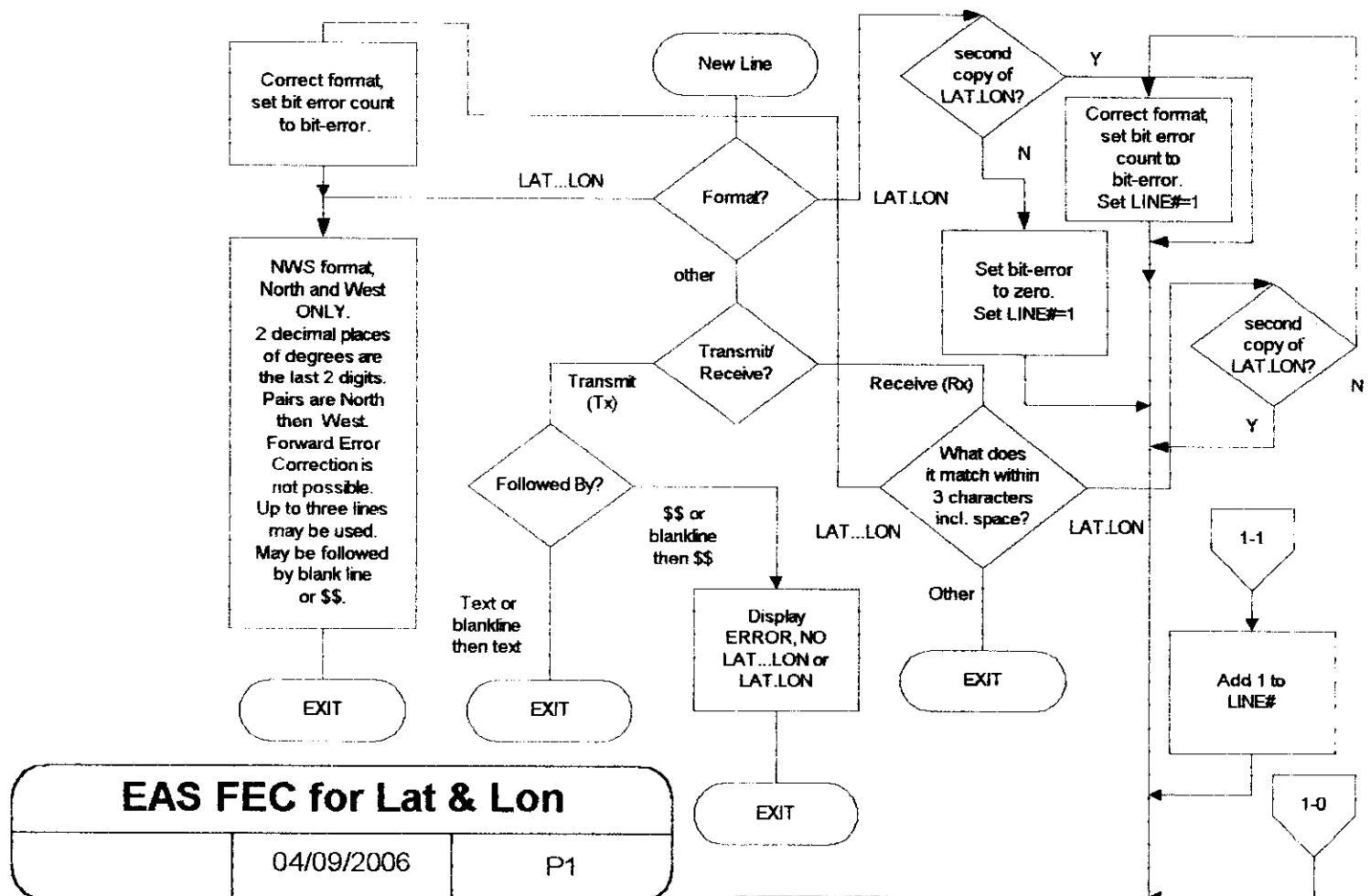
DGPS DGPS Station ID, 4 characters

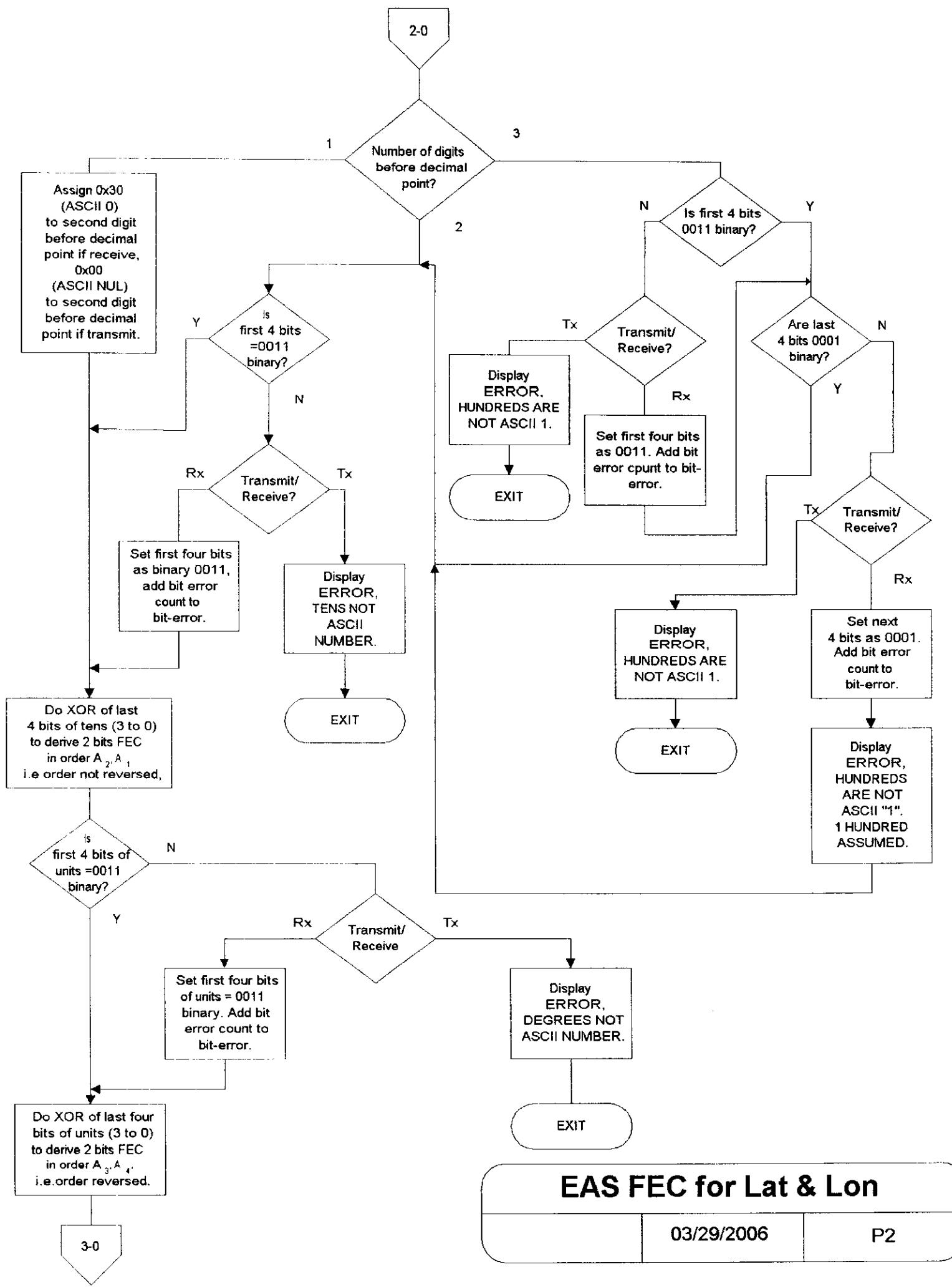
CHK Checksum, 3 characters.

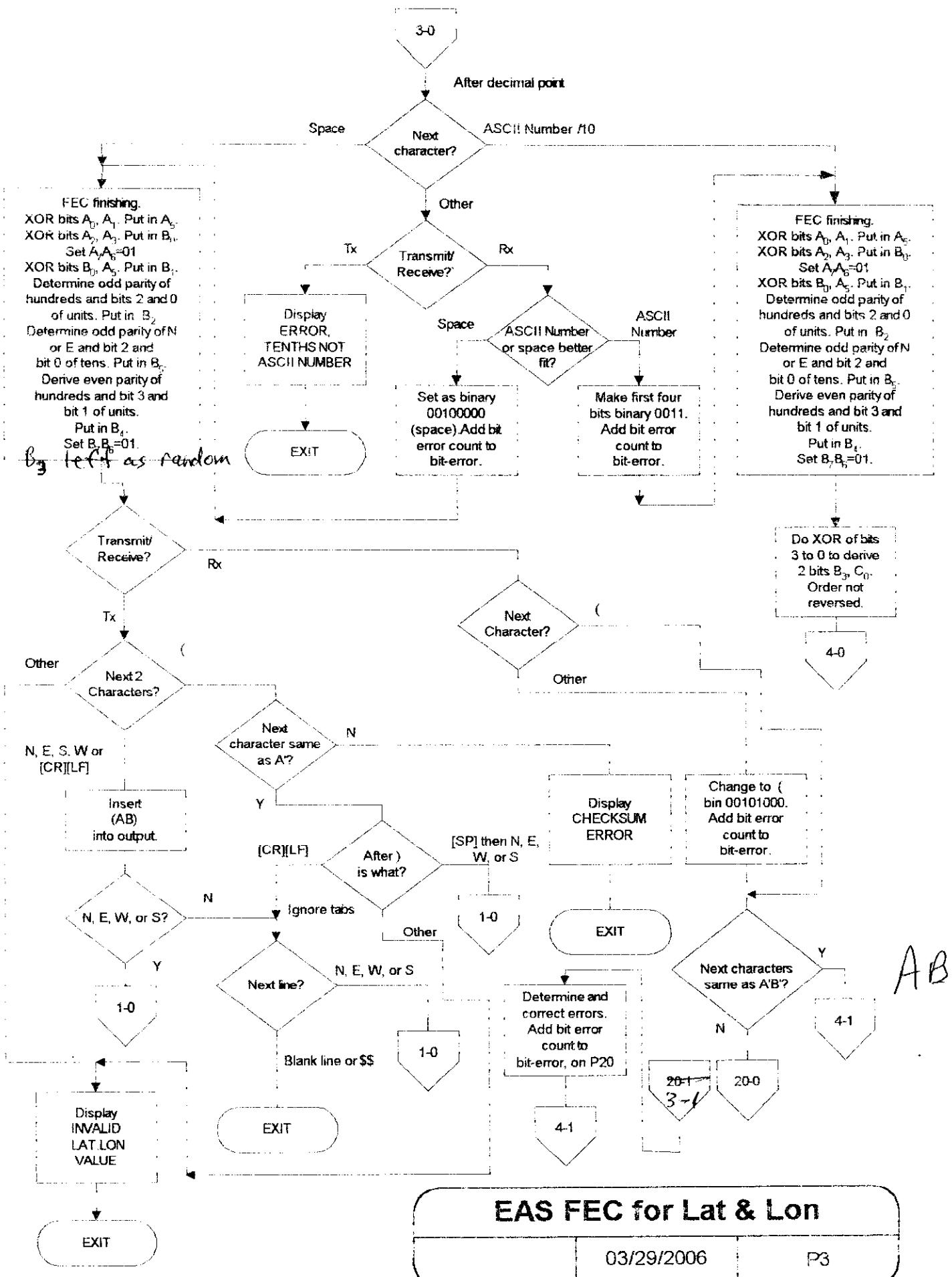
[CR][LF] carriage return, line feed

The NMEA (www.nmea.org) first published this in January 1983. The use of minutes is because navigators used paper charts which had degrees and minutes on. A format to transmit polygons from a receiver to a videoplotter is being researched. The U.S. Census Department and U.S. Geological Survey use and prefer an ArcView Shapefile format.

NMEA could be engaged to formulate a polygon standard sentence. There are some proprietary formats existing. However this format does not provide for error correction and the associated bit error and quality assurance, so a translation application would have to be developed between this format and EAS.







EAS FEC for Lat & Lon

03/29/2006

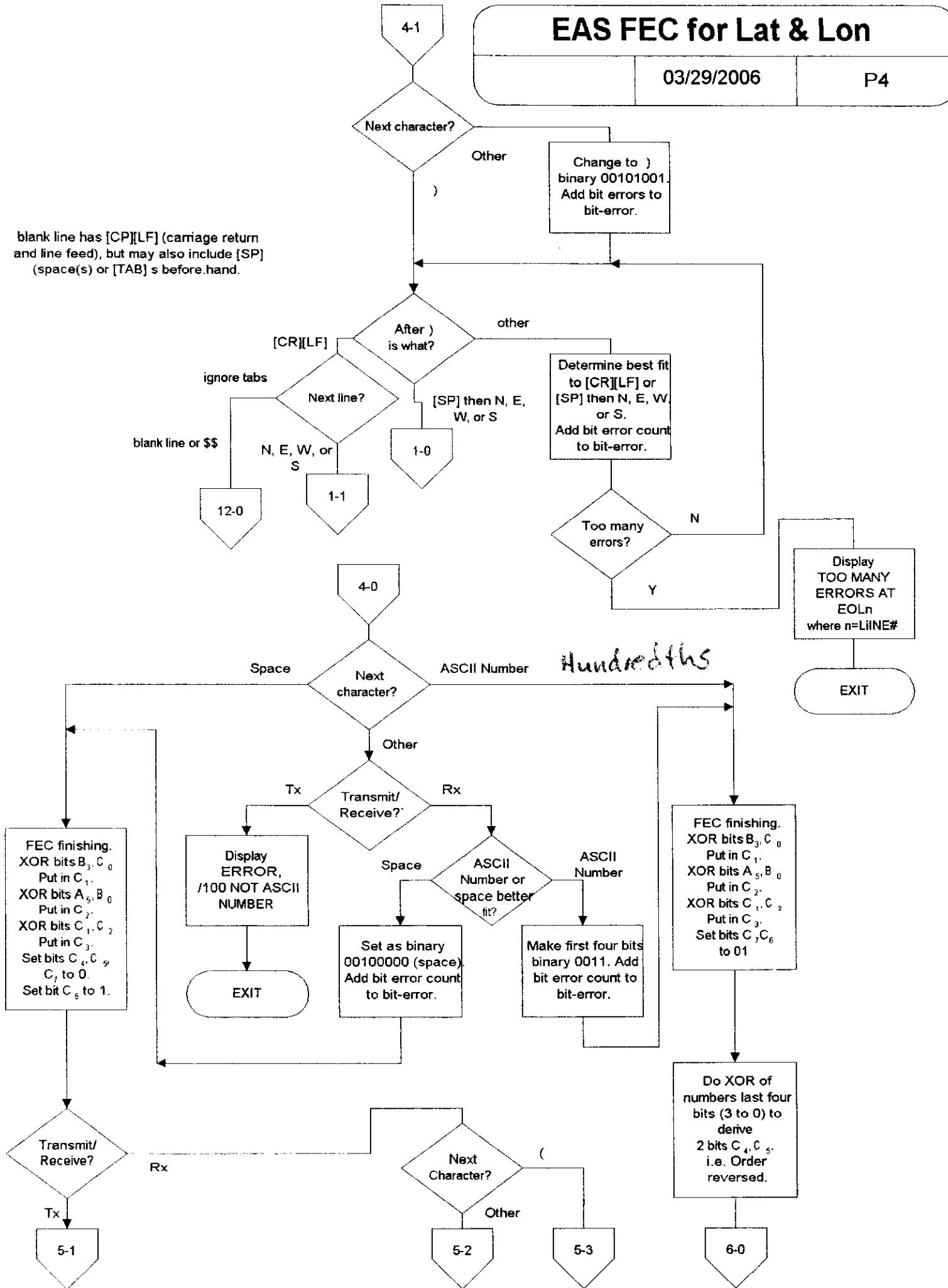
P3

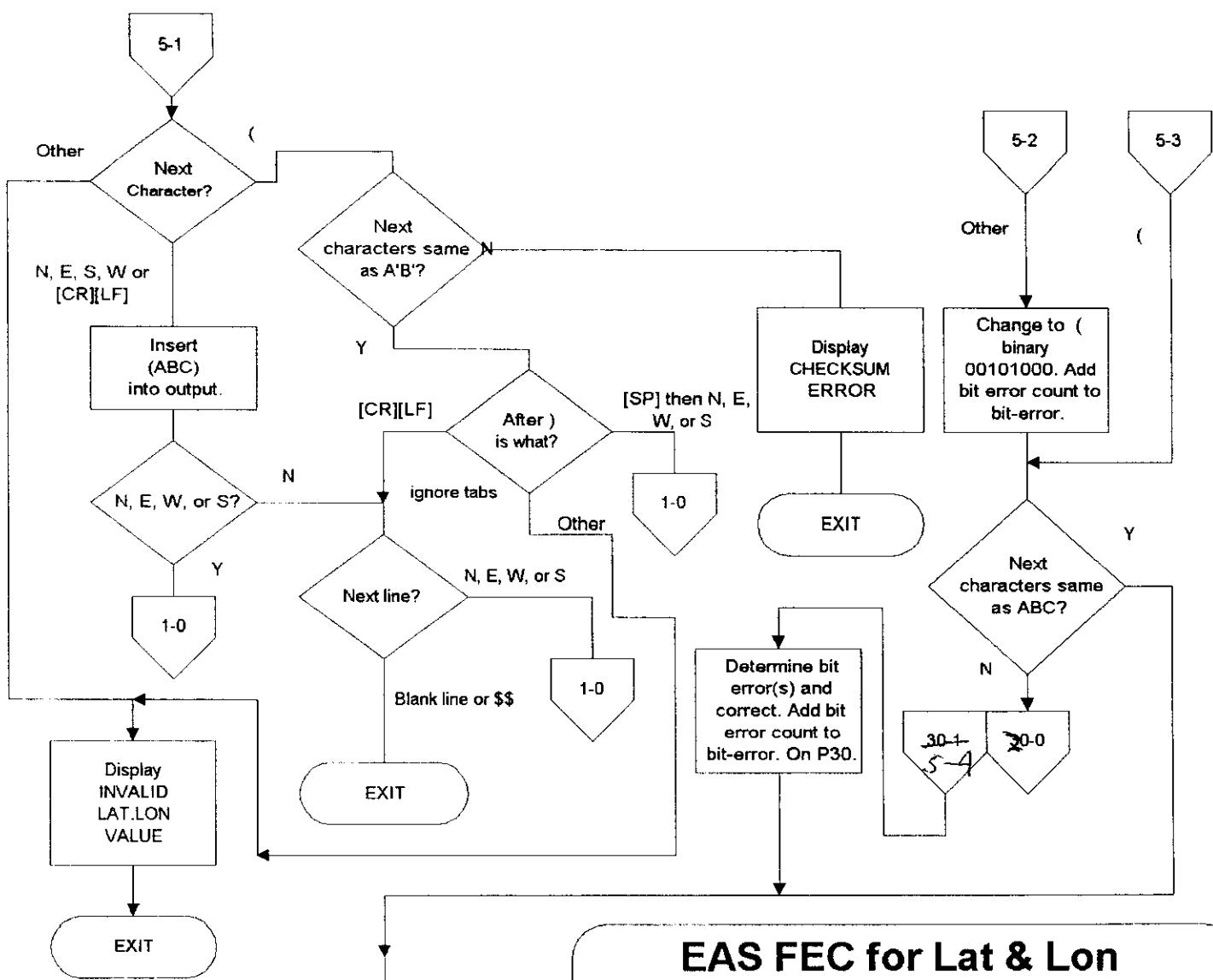
EAS FEC for Lat & Lon

03/29/2006

P4

blank line has [CR][LF] (carriage return and line feed), but may also include [SP] (space(s) or [TAB] s before hand).

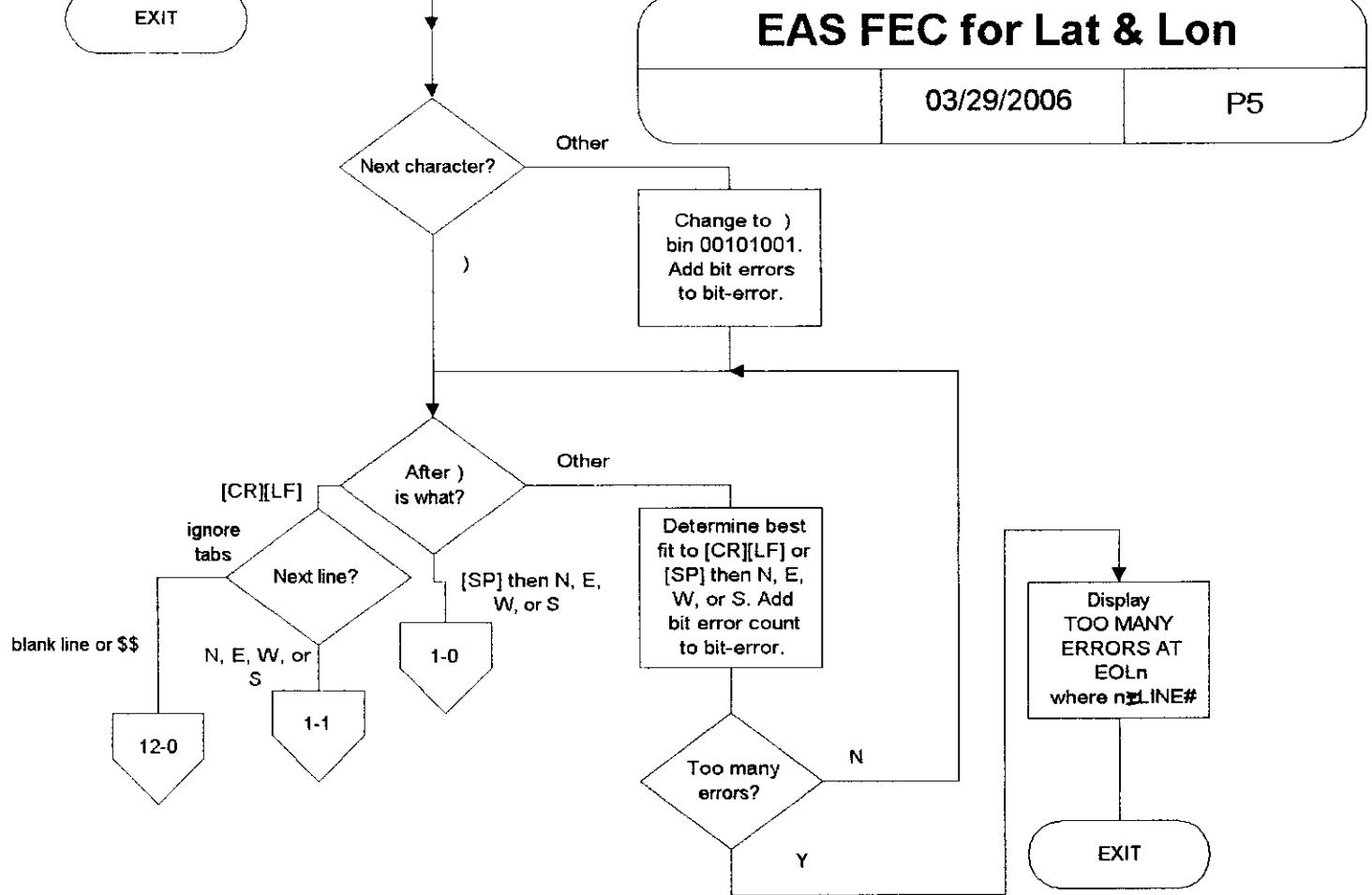




EAS FEC for Lat & Lon

03/29/2006

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EAS FEC for Lat & Lon

6-0

03/29/2006

P6

Space

Next character?

ASCII Number /1k

Other

Tx Transmit/ Receive?

Rx

Space

ASCII Number or space better fit?

ASCII Number

FEC finishing.
XOR bits C₄, C₅
Put in D₀.
XOR bits D₀, C₃
Put in D₁.
Derive odd parity of
bit 2 and bit 0 of
tenths.
Put in D₂.
Derive even parity of
bit 3 and bit 0 of
hundredths.
Put in D₃.
XOR of D₂ and D₃
Put in D₄.
Set highest 3 bits as
010

Display
ERROR,
/1k NOT ASCII
NUMBER

EXIT

Set as binary
00100000 (space).
Add bit error count
to bit-error.

Make first four bits
binary 0011. Add
bit error count to
bit-error.

FEC finishing.
XOR bits C₄, C₅
Put in D₀.
XOR bits D₀, C₃
Put in D₁.
Derive odd parity of
bit 2 and bit 0 of
tenths.
Put in D₂.
Derive even parity of
bit 3 and bit 0 of
hundredths.
Put in D₃.
XOR of D₂ and D₃
Put in D₄.
Set highest 3 bits as
010
to be modified as
below.

Do XOR of last
four bits (3 to 0)
to derive
2 bits D₅, E₀.
i.e. Order
reversed.

8-0

Other

Transmit/
Receive?

Rx

Next
Character?

N, E, S, W or
[CR][LF]Insert
(ABCD)
into output.

N, E, W, or S?

1-0

Next
characters same
as A'B'C'?

[CR][LF]

N

Y

N

Y

After) is what?

Other

[SP] then N, E,
W, or S

1-0

Display
CHECKSUM
ERROR

Change to (
binary 00101000.
Add bit error count
to bit-error.

EXIT

(

)

Other

Y

Next
characters same
as ABCD?

N

Determine bit
error(s) and
correct. Add bit
error count to
bit-error. On P40

48-17
6-1
70-0

7-0

EXIT

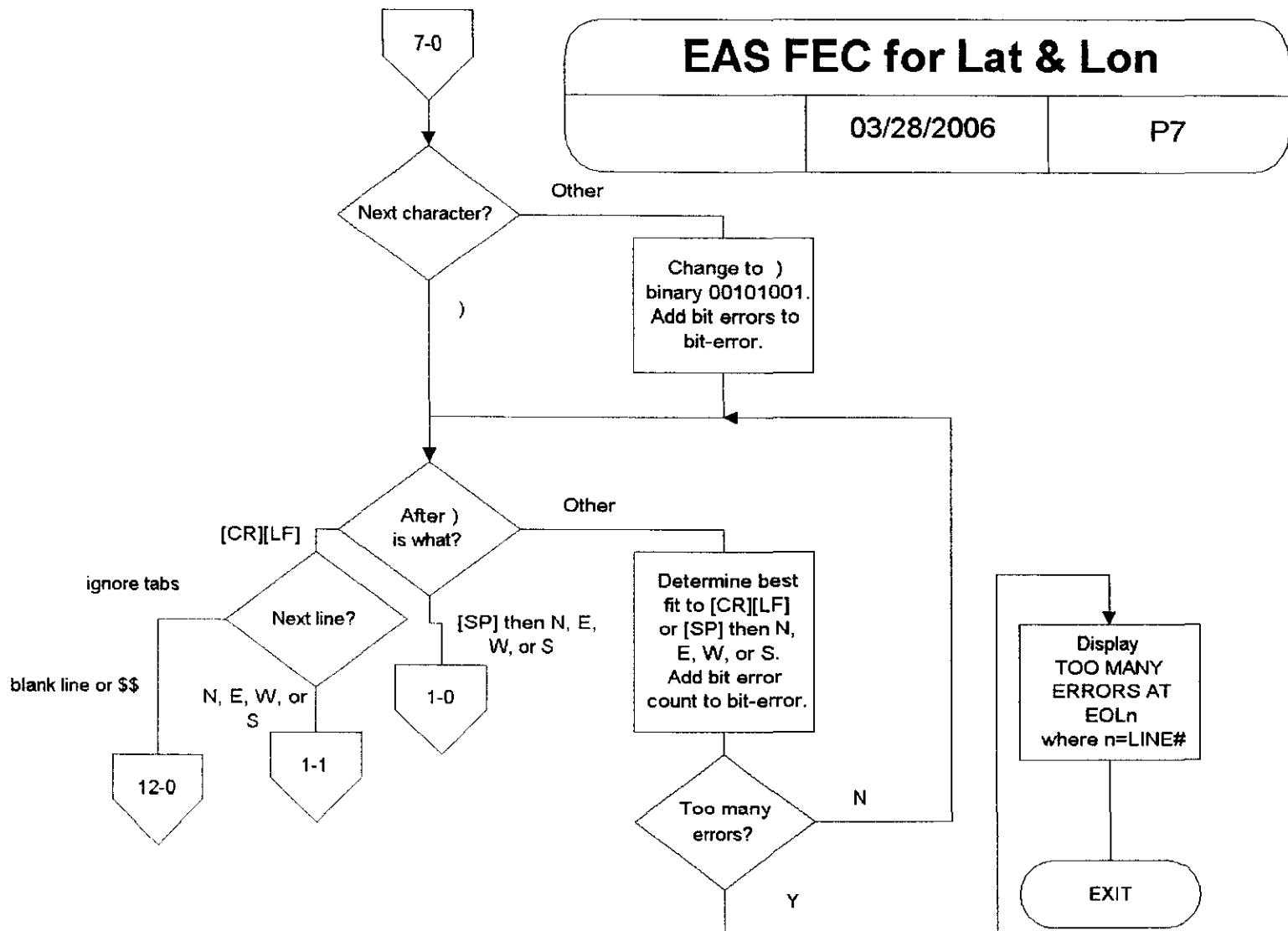
INVALID
LAT.LON
VALUE

EXIT

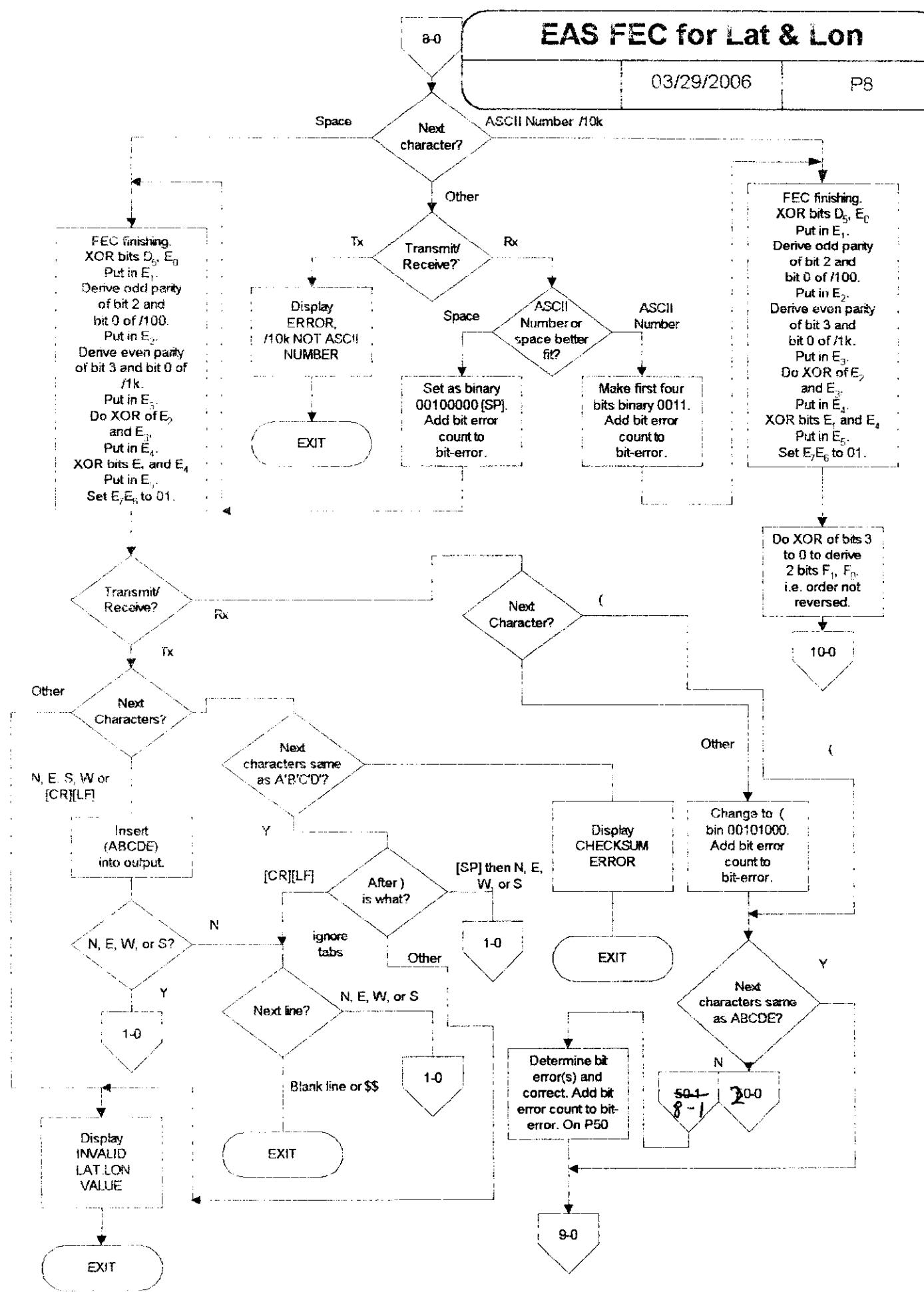
EAS FEC for Lat & Lon

03/28/2006

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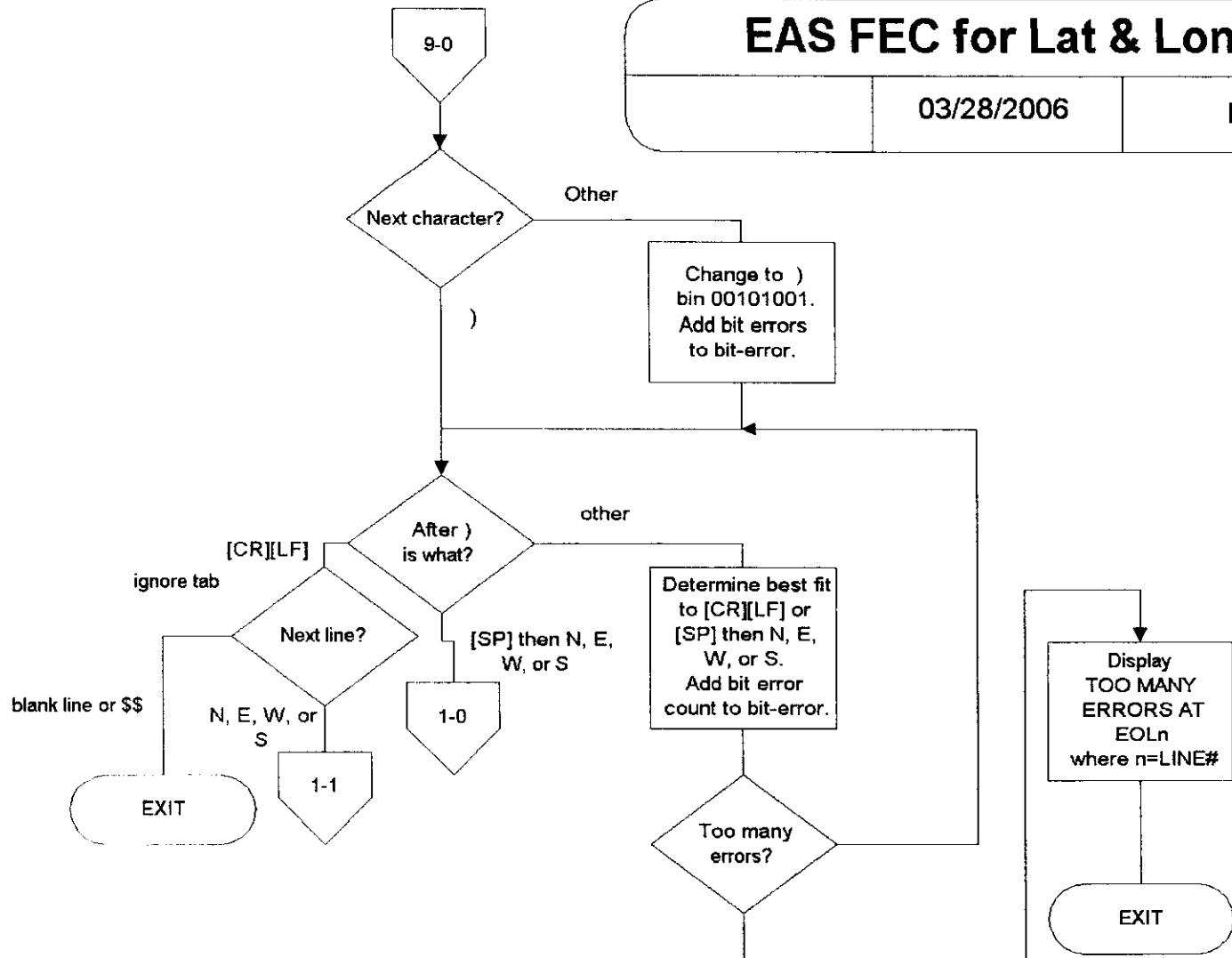
EAS FEC for Lat & Lon



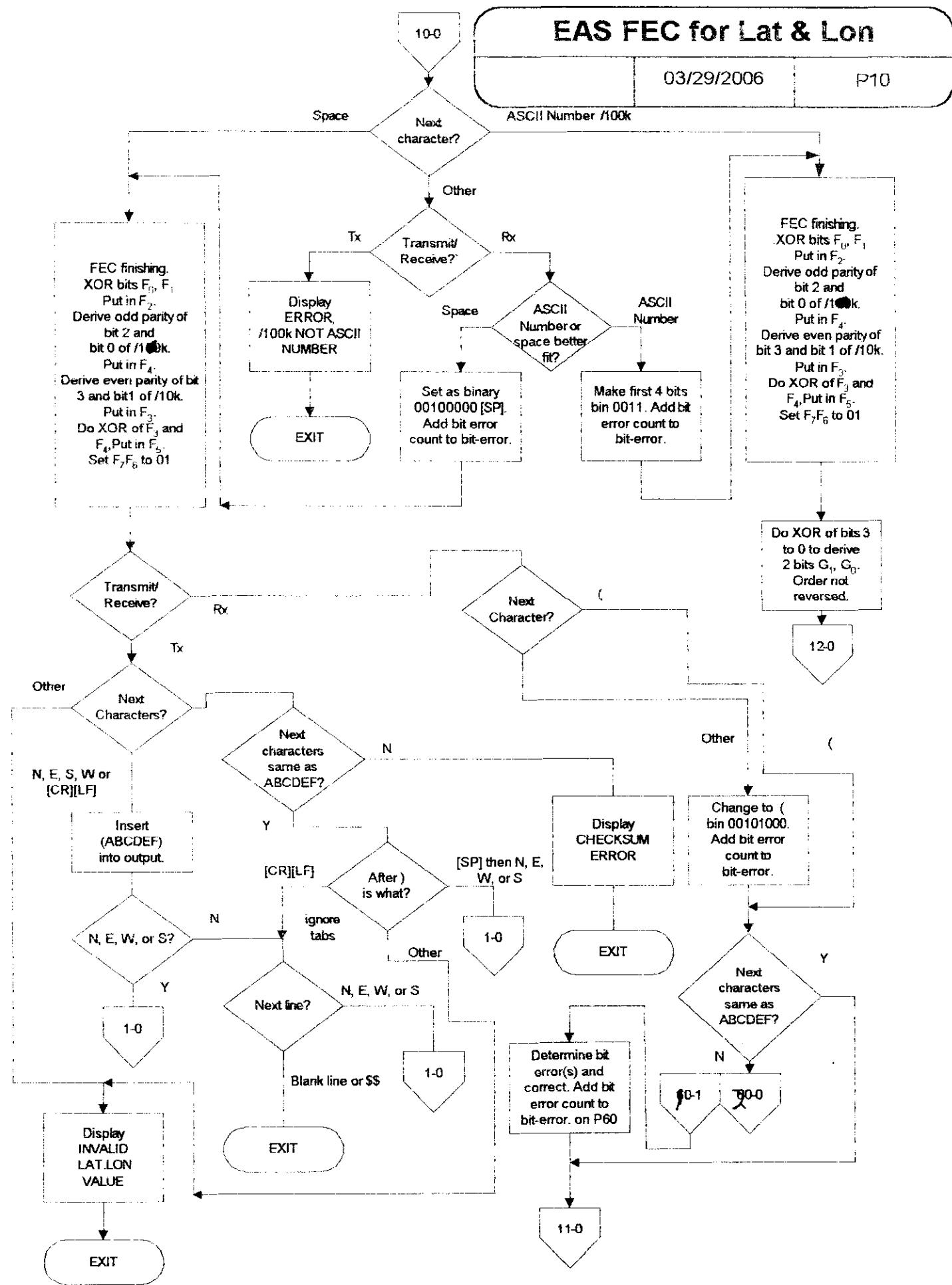
EAS FEC for Lat & Lon

03/28/2006

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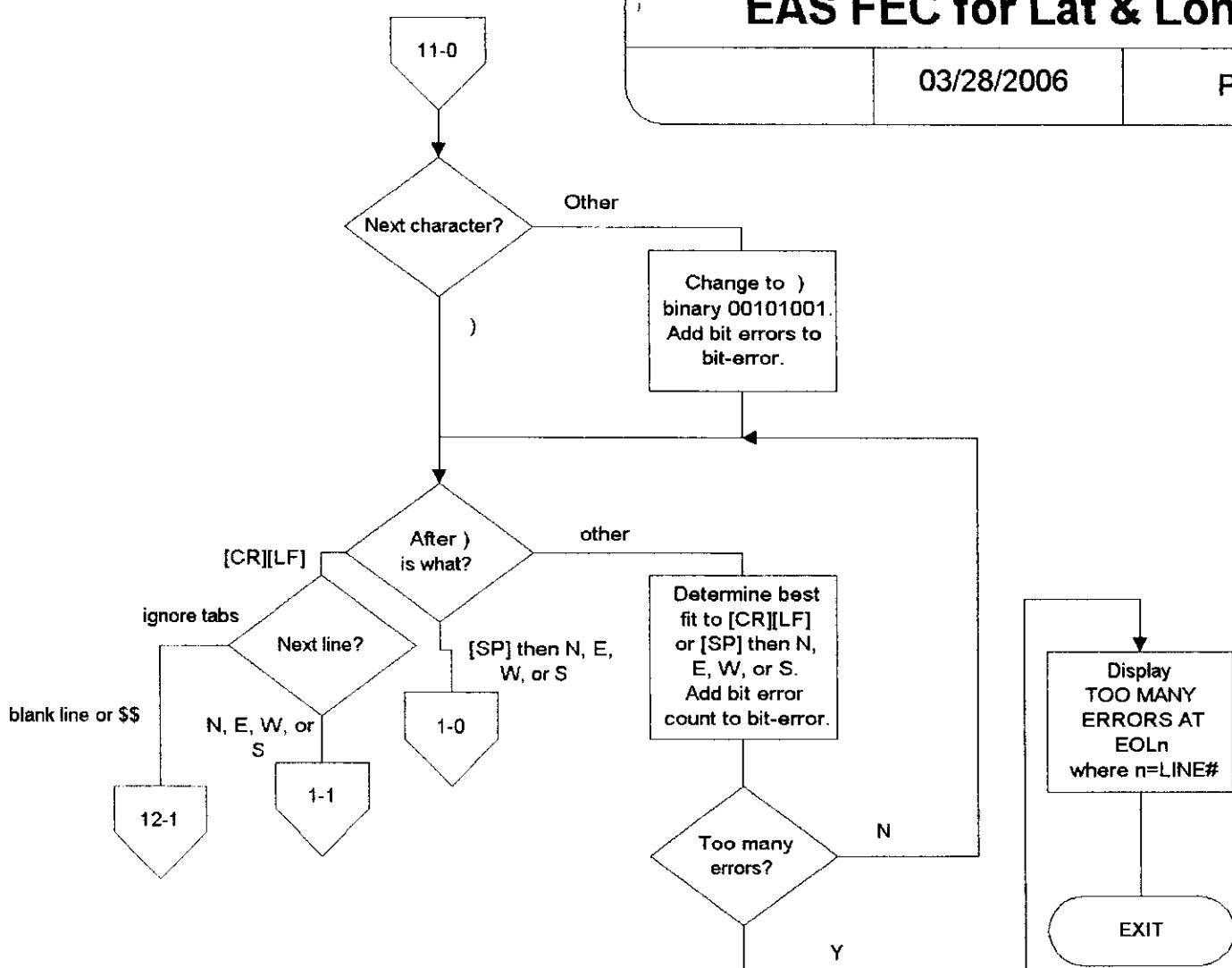
EAS FEC for Lat & Lon



EAS FEC for Lat & Lon

03/28/2006

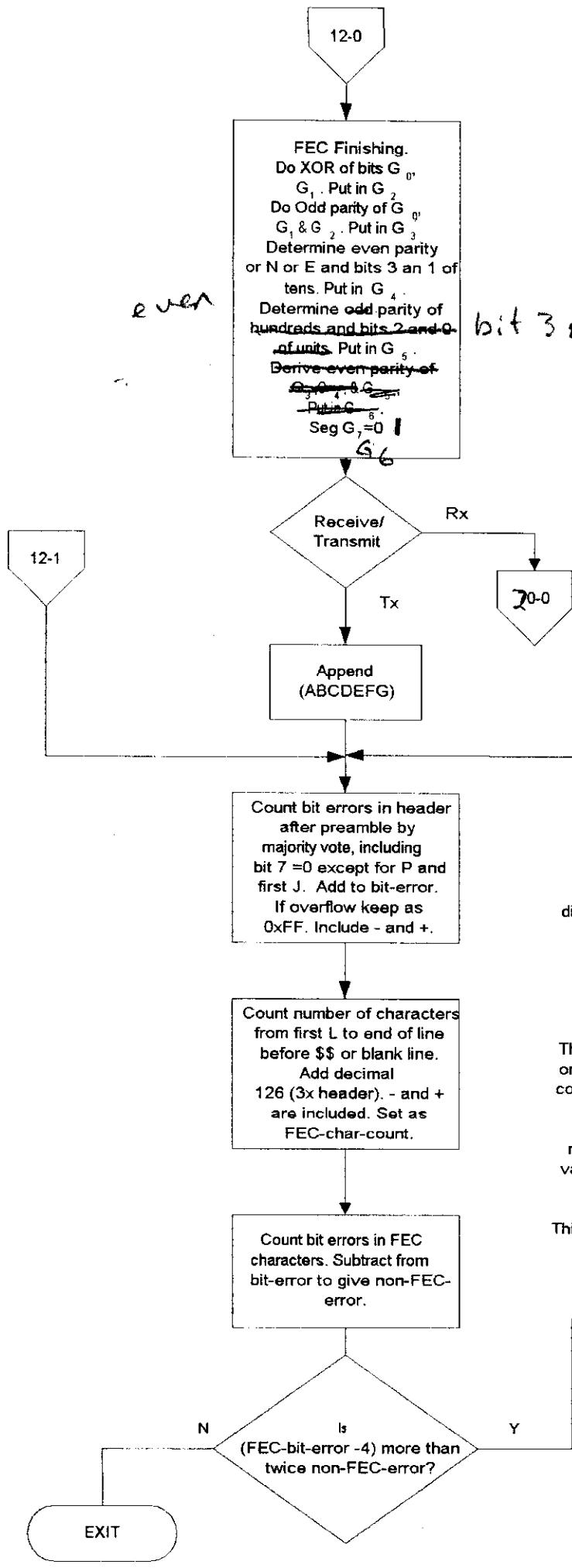
P11



EAS FEC for Lat & Lon

03/29/2006

P12



The algorithm to determine the bit errors is not described here. Basically the strategy is to start at the finishing XOR and parity statements if the values are different, work back from the correct statement(s) to the cause(s) in both manners to determine which are therefore the incorrect bit(s).

*May be
(369 character or
2952 bits if cat. 6
is repeated)*

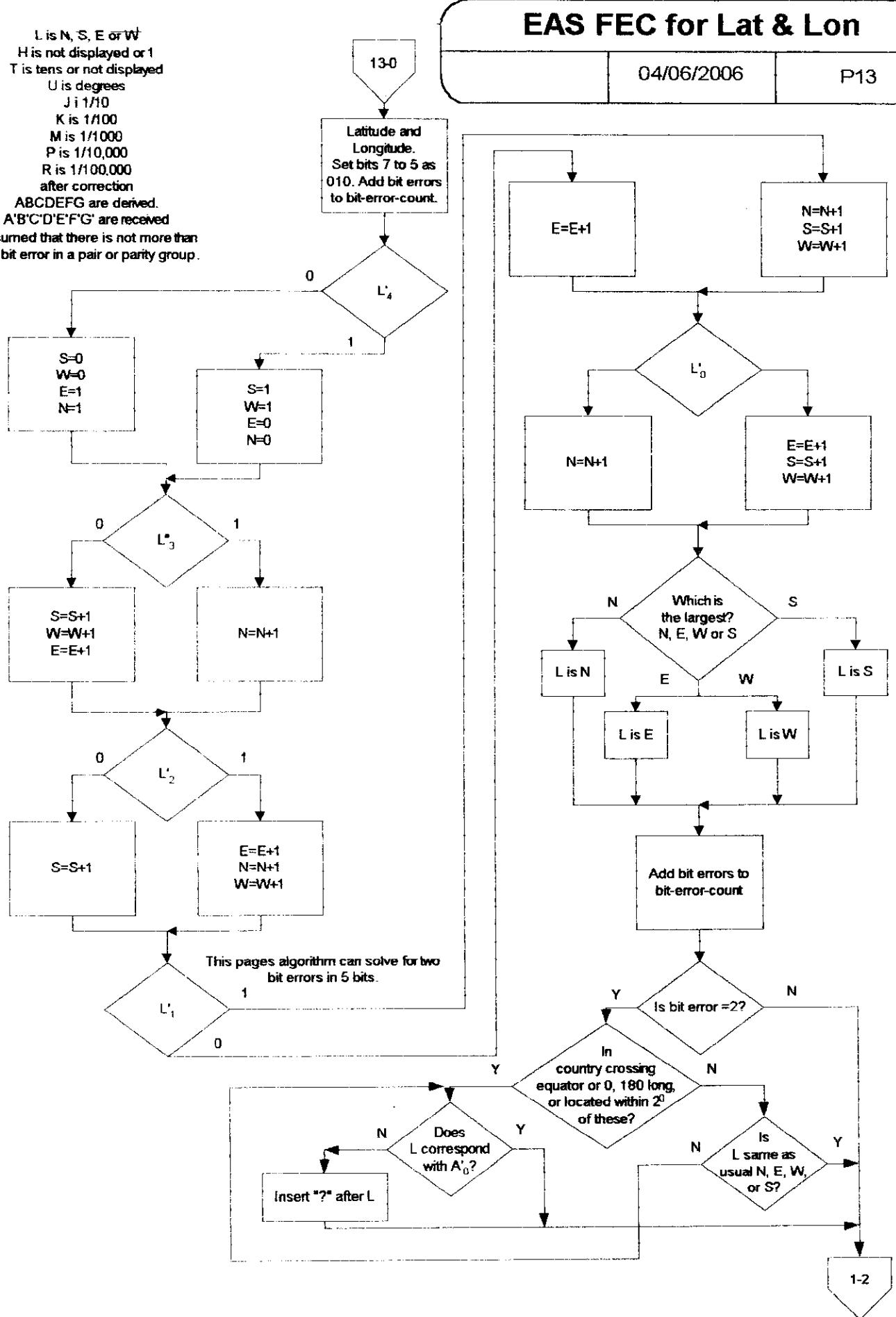
This is up to a total of about 233 characters, or 1864 bits. This, together with the bit-error count above is enough to report a reasonable illustration of the Bit Error Rate.

BER=bit-error/FEC-char-count. This is normally written as a scientific exponential value, e.g. $5.4 \cdot 10^{-4}$ for $5.4 \cdot 10^{-4}$ for 1 error bit in this example. This algorithm should function with severe error rates.

This bit error rate reporting is an essential part of Quality Assurance and Control.

EAS FEC for Lat & Lon

L is N, S, E or W
 H is not displayed or 1
 T is tens or not displayed
 U is degrees
 J is 1/10
 K is 1/100
 M is 1/1000
 P is 1/10,000
 R is 1/100,000
 after correction
 ABCDEFG are derived.
 A'B'C'D'E'F'G' are received
 Assumed that there is not more than one bit error in a pair or parity group.

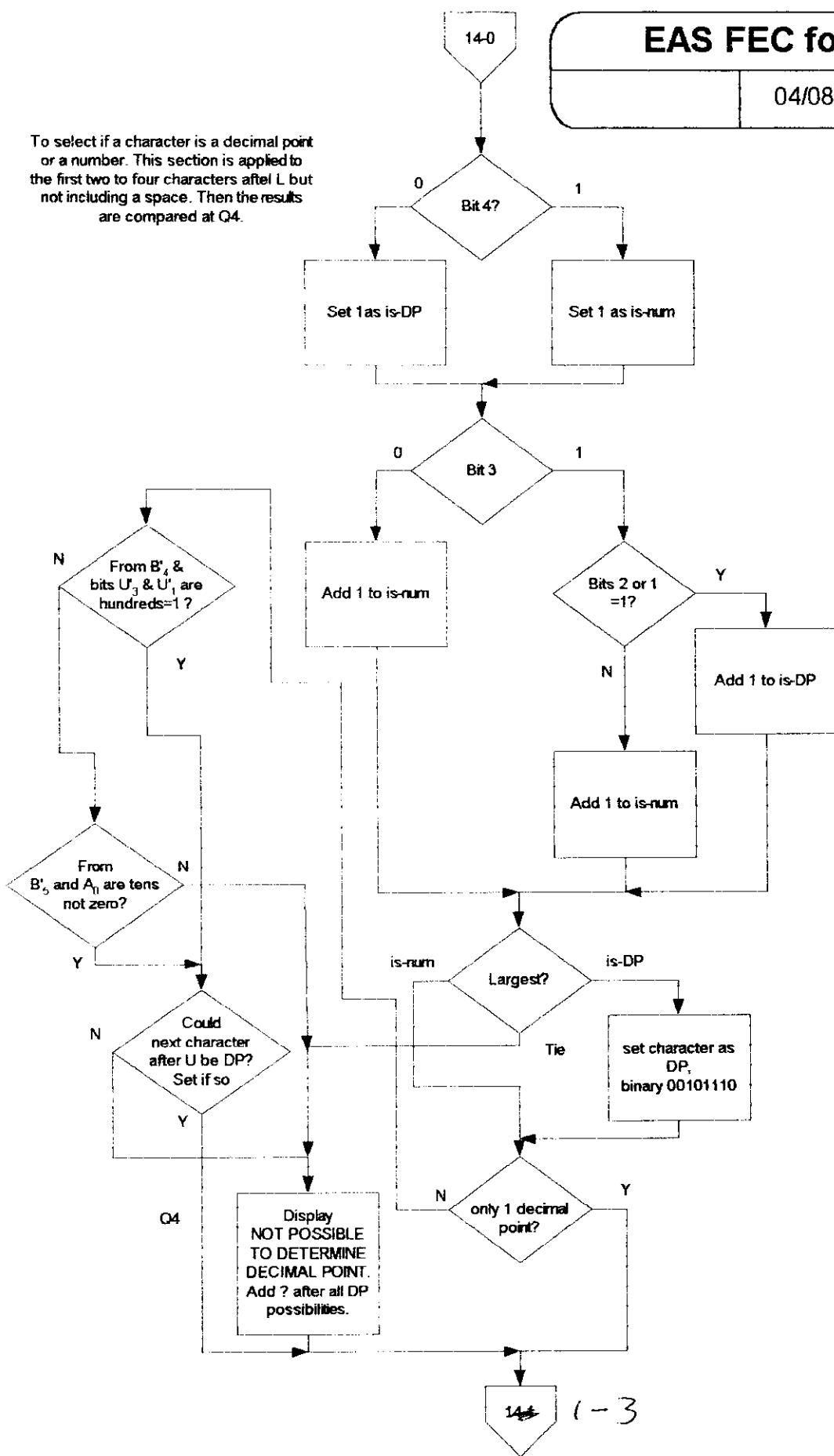


EAS FEC for Lat & Lon

04/08/2006

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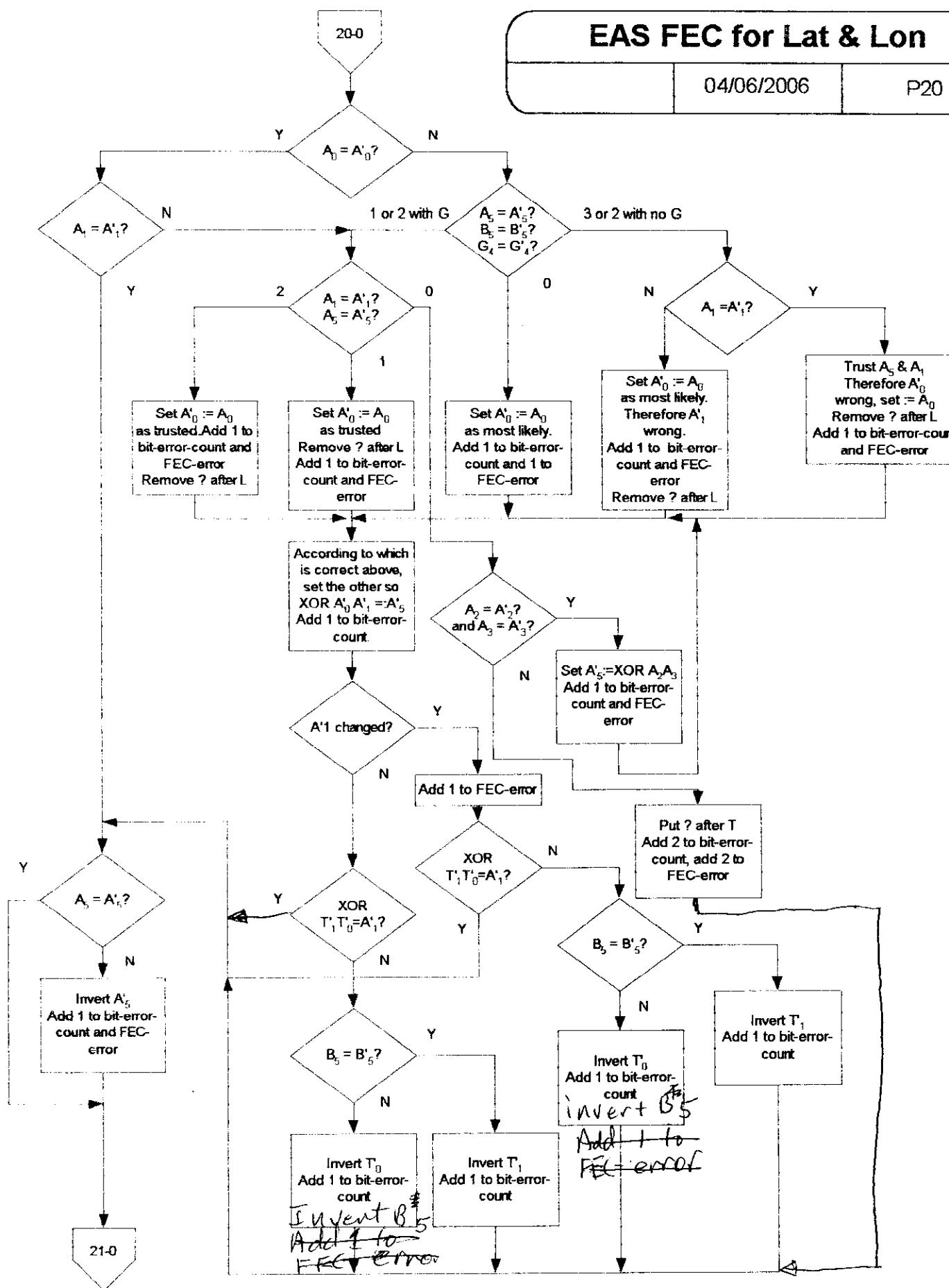
To select if a character is a decimal point or a number. This section is applied to the first two to four characters after L but not including a space. Then the results are compared at Q4.



EAS FEC for Lat & Lon

04/06/2006

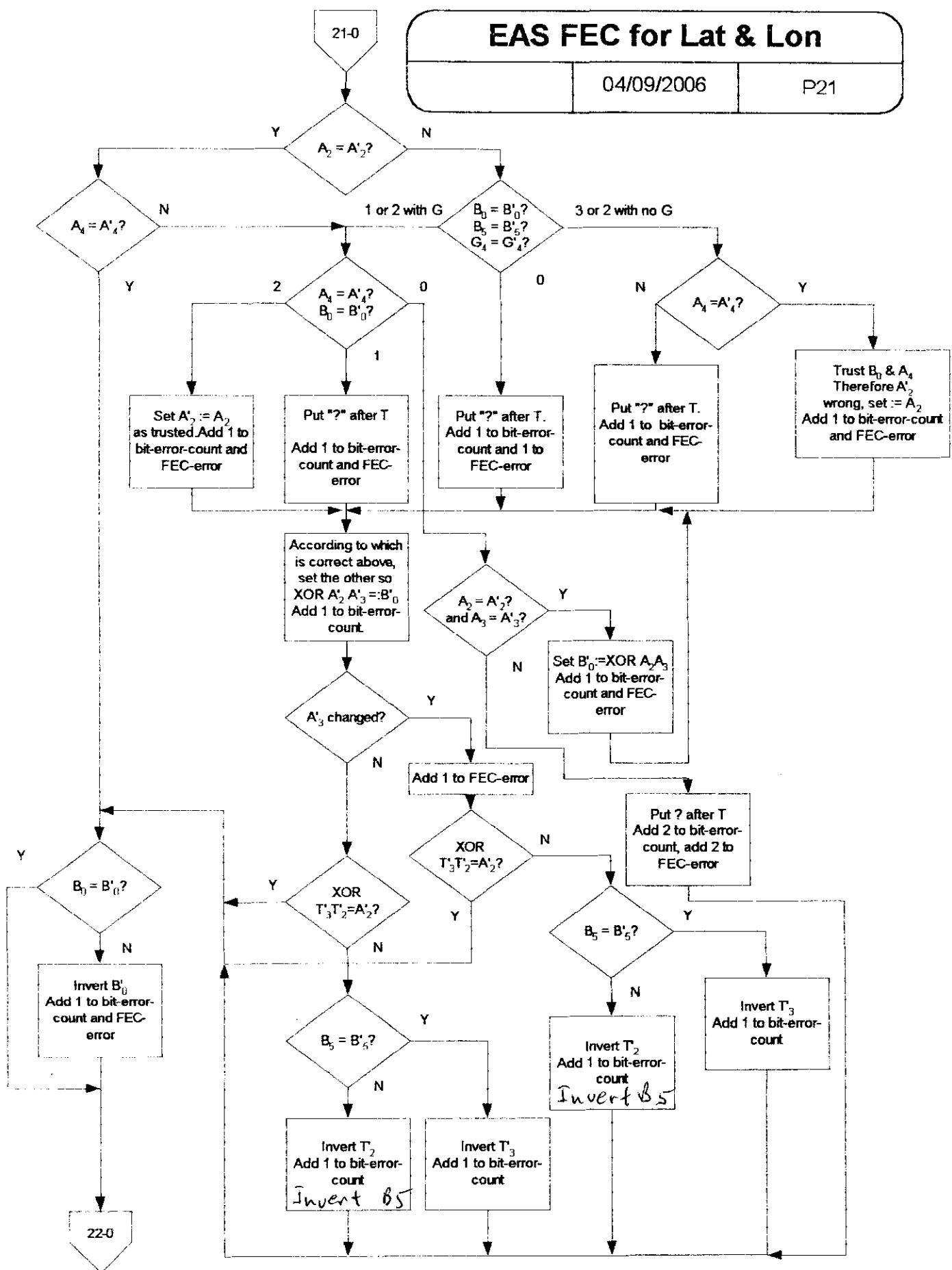
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EAS FEC for Lat & Lon

04/09/2006

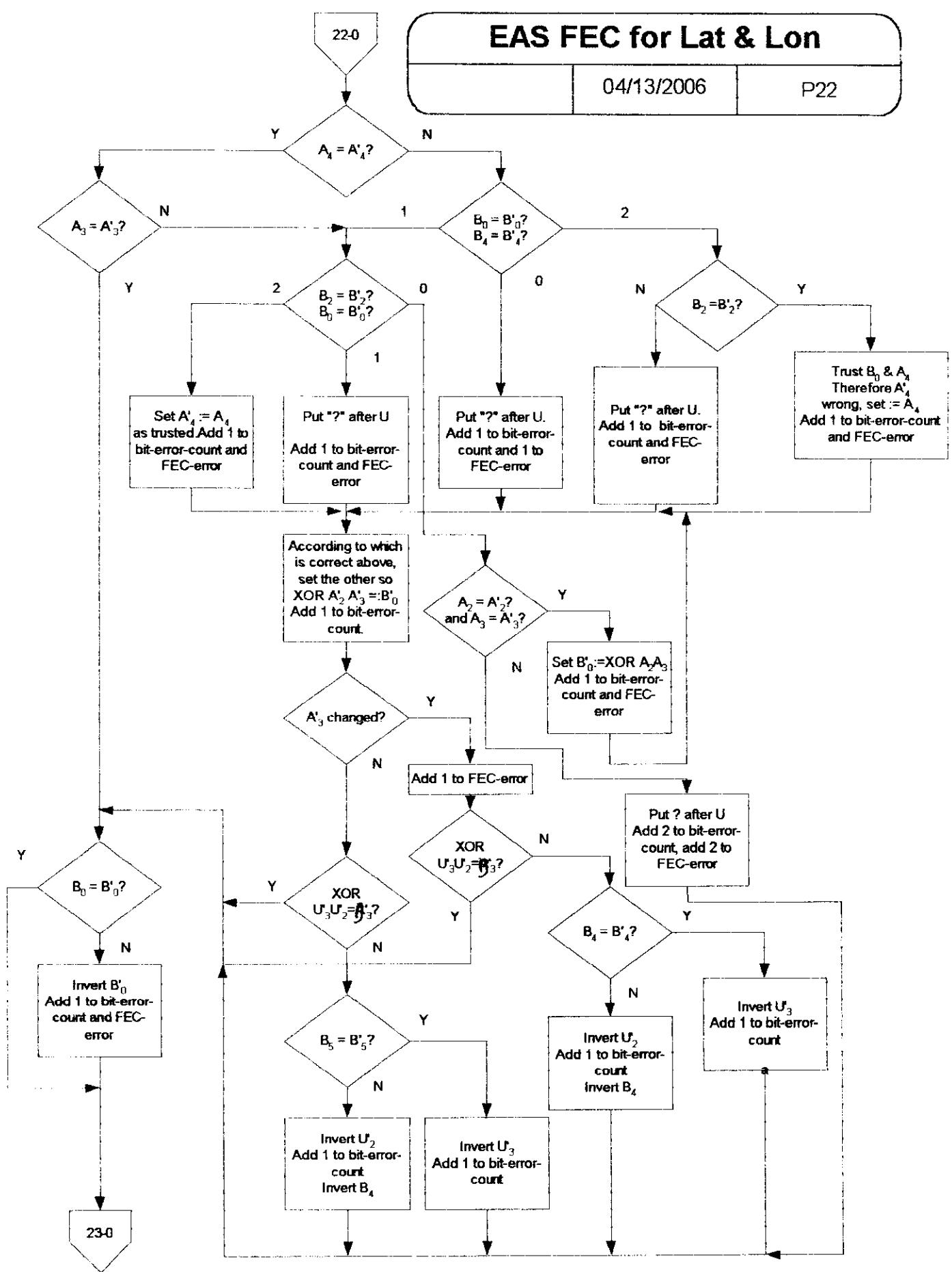
P21



EAS FEC for Lat & Lon

04/13/2006

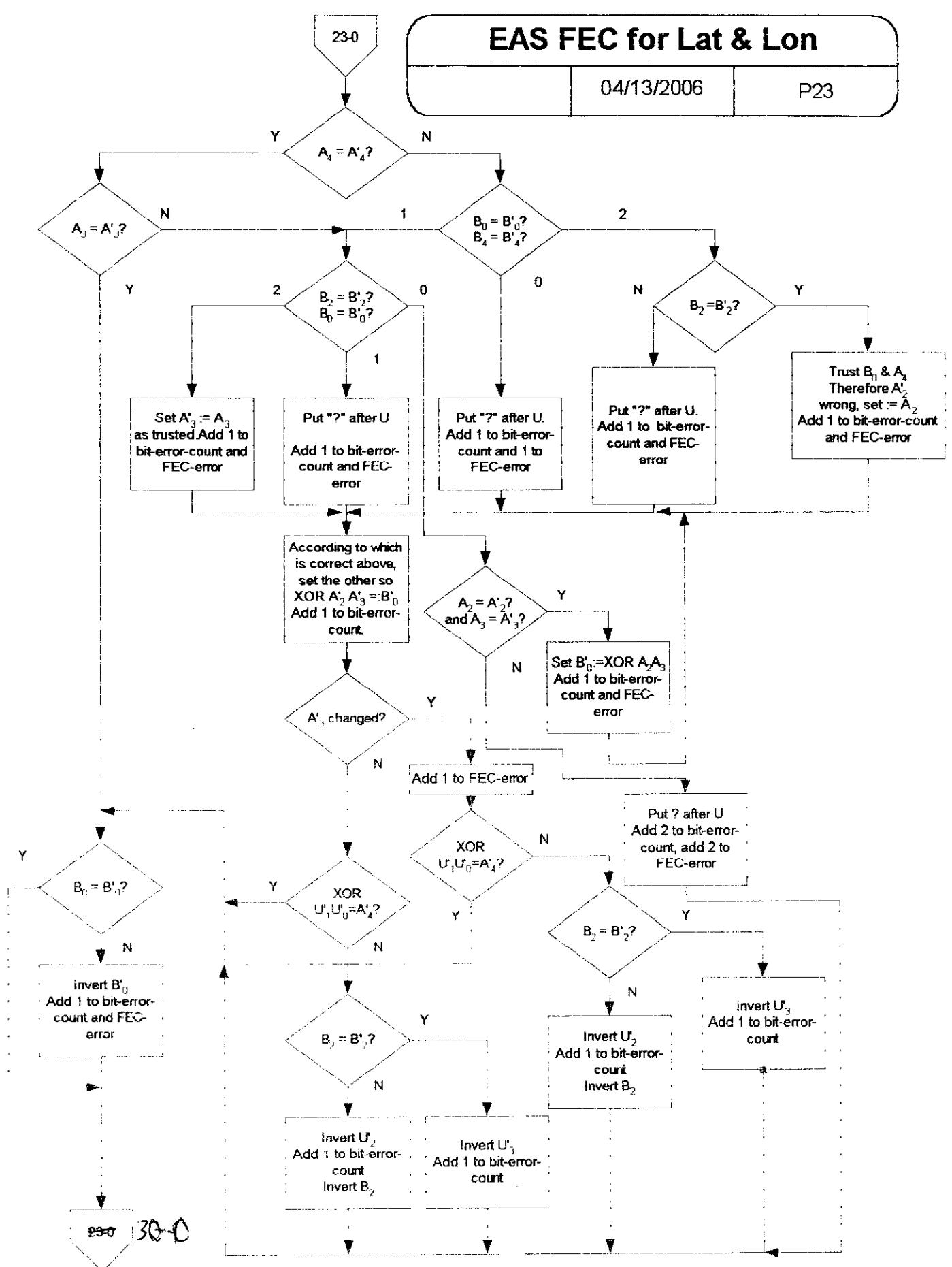
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EAS FEC for Lat & Lon

04/13/2006

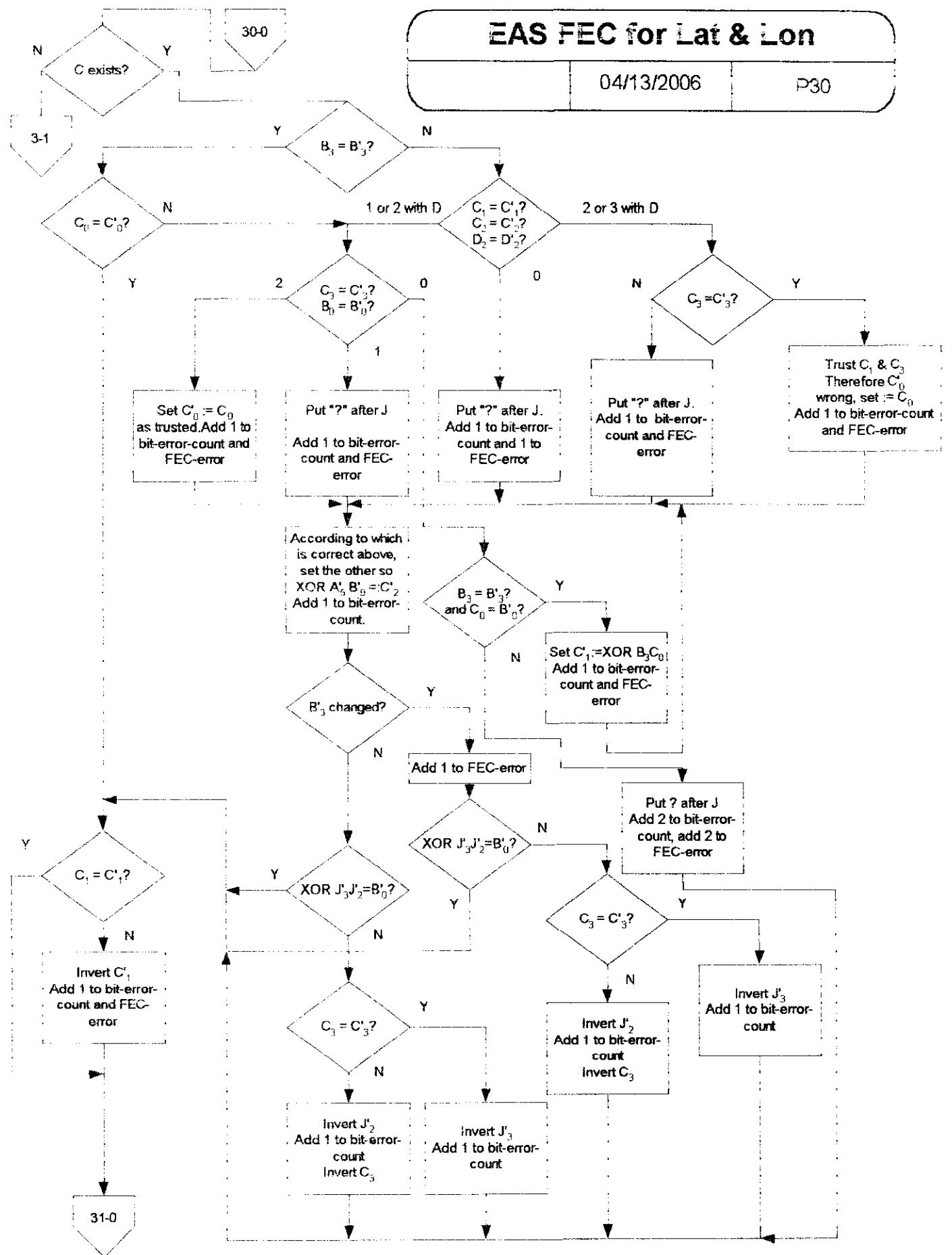
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EAS FEC for Lat & Lon

04/13/2006

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EAS FEC for Lat & Lon

04/16/2006

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